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ABSTRACT

This study examined the way children learn about and use the novel features of videodiscs. Nine 9- and 10-year-old students in a progressive private school in New York City participated in the study. None had prior experience with videodisc technology. The two videodiscs which served as test materials--"The First National Kidisc" and "Fun and Games"--were selected because they encourage use of the special video and audio features of videodiscs. Subjects worked in pairs for two 45-minute sessions. Sessions were observed by a researcher who took notes on the children's behavior and comments. Results are reported in three sections: (1) initial learning of the disc options, the role of disc-based instructions and prompts in learning, and technical aspects of the hardware that were impediments to learning; (2) use of audio options and use of visual options in relation to several general goals, such as navigating around the disc and playing with the speed and direction of images; and (3) use of disc options to manipulate the presentation in accordance with children's interests and playing styles. It is concluded that children are able to handle videodisc programming that leaves open the opportunity for exploration and self-motivated learning. (7 references) (MES)

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CHILDREN'S USE OF THE UNIQUE FEATURES OF INTERACTIVE VIDEODISCS

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Optical videodiscs are capable of storing vast amounts of video pictures, sound, and text, which can then be called up quickly and easily and worked with in a variety of ways. Since its introduction in the late 1970s, videodisc technology has been hailed by many as a medium that has great potential as an educational tool because of its ability to support increased user control and interactivity.

Standard videodisc players offer a range of unique technical features: two independent sound tracks, freeze-frame capability, variable play speed, and frame-accurate searching. With these features users can, for example, switch to an alternate sound track with the press of a button; stop on any image indefinitely; slow down, speed up, reverse, or repeat any video segment; or jump immediately to any of 54,000 individual images on a disc.

Indeed, it is these features that give videodisc its "interactive" potential and could allow students to exercise meaningful control over material in pursuit of a specific goal. For example, a videodisc on how archeologists collect data might feature two independent audio tracks for the same video segment, thus enabling students to choose between easy and advanced levels of instruction according to their individual needs. An audio track for beginners might highlight the tools used during a dig, while one for more advanced students might discuss ways of making inferences from different kinds of data. Disc content could be structured so that decision points (manifested in menu choices or other program options) support a range of learning styles and goals. Such videodisc features as these could allow individuals to progress through the disc contents in ways that reflect their own abilities, interests, and inclinations.

In light of the above, many people see videodisc technology as an enormous breakthrough for engaging children's interest and conveying information. Leaders in the educational community and in industry commonly assume that because these special features exist, users will readily avail themselves of the options, thereby reaping significant learning benefits. Yet, to date, little research has examined the consequences of these new technical features for children's learning

or seriously explored the unique advantages of this medium for learning and instruction.

Much of the research conducted thus far are evaluations of educational discs, which focus on the learning of specific factual content featured on the discs (e.g., Brown & Newman, 1980; Bunderson, Olsen, & Baillio, 1981). Others are reports of focus groups composed of audiovisual media directors and teachers reacting to brief videodisc demonstrations (e.g., Massachusetts Educational Television, 1981; Videodisc Design/Production Group, 1979), or of anecdotal accounts by educators (Ferralli & Ferralli, 1985). Focused, observational studies on the ways children utilize videodisc features to exercise greater control over their learning paths are, to our knowledge, largely nonexistent.

As part of a larger program of research on the educational potential of videodiscs for children's learning undertaken by the Interactive Video Project at Bank Street College, we conducted an observational study of the way children learn about and make use of the novel features of videodiscs. At the most general level, we were interested in the issue of control of the medium and whether children could take advantage of such control in directing their experience of a disc's material.

Many videodiscs have been designed with three assumptions in mind: that children will recognize a videodisc environment as being distinct from linear television; that they can learn to use the videodisc features successfully and in the pursuit of particular goals; and that children's progress through the videodisc contents will in some ways be unique for each child or group of children, reflecting a range interests and abilities. Accordingly, the questions we have asked about children's use of videodisc features attempt to examine the following general expectations:

1. Do children recognize that there are options they can exercise in viewing videodisc material, and are they motivated to do so? How quickly do they learn to use the novel features of videodiscs? What role do different kinds of disc-based instructions and prompts play in such learning? We anticipated that simply having the ability to stop, speed up, or reverse a sequence of video images would encourage children to adopt a more active attitude toward the material than would be present with traditional viewing.

2. Once students are familiar with the disc conventions, are their selections more or less random or do they meaningfully apply the disc capabilities to particular game and learning goals? Children's use of the dual audio track feature, one of the more novel aspects of

videodiscs, was of particular interest here. For example, we wanted to know whether children, when selecting one of two available audio tracks, would choose randomly or base their decisions on an assessment of which track was most appropriate to their interests and intentions.

3. After children have spent time working with the videodisc, a number of more general questions may be asked. Can the same videodisc segment, by encouraging use of multiple disc options, support a variety of interactions across children or across extended disc play? Does the flexibility of the medium encourage children to make up activities of their own, to modify the intended goals of the material to suit their own interests and inclinations?

Methods

Sample

Nine children participated in the study, four boys and five girls, all of whom were 9 or 10 years old. The children were students in a progressive, private school in New York City. None of the children had prior experience or familiarity with videodisc technology.

Disc Materials

The two videodiscs that served as test materials were The First National Kidisc and Fun and Games, both by Optical Programming Associates. These discs were selected after an extensive review of existing educational discs (Char & Newman, 1985) because they encourage the use of nearly all of the special video and audio features of videodiscs, in contrast to the limited usage of most instructional discs. In addition, they offer children an assortment of games, puzzles, and how-to activities, such as making paper airplanes, doing magic tricks, and playing frisbee. While the discs are primarily designed for home entertainment, they also incorporate learning activities on such topics as sign language, code making, and the flags of the world.

Each activity corresponds to an individual chapter on the disc. The two-sided Fun and Games disc has 40 chapters; the one-sided Kidisc has 25 chapters. In both discs, the chapters can be accessed using the CHAPTER SEARCH option, allowing users to go directly to the start of the desired segment.

Both Kidisc and Fun and Games begin with a 2- or 3-minute tutorial on how to use the disc options hosted by an adult or child who appears in other segments on the disc.

Many disc segments encourage the user to utilize the visual and audio options in flexible ways, offering different presentations of the same audio and visual material. For example, in "Discomobile," a simulated drive through a New England town, users can manipulate the visual presentation by slowing down the images to study objects in a store front, by reversing play to watch a train pull in a second time, or by freezing the image on each stop sign that appears. In segments that offer the dual audio track option, users can choose between separate sound tracks to hear different levels of instruction or types of information, such as how to throw and skip a frisbee or how pinatas were once made. Table 1 highlights some of the ways that visual and audio options such as SLOW SPEED, STILL/STEP, REVERSE, DUAL AUDIO, and CHAPTER SEARCH are employed in a variety of segments.

Once accessed, PLAY allows the disc segment to be presented at the normal playing speed of 30 frames a second. SLOW SPEED can be varied or can allow the user to view the segment at 1/5 normal speed (6 frames a second), while STILL/STEP allows one to stop on an individual frame and step through one frame at a time. FAST FORWARD allows the user to see the segment three times faster than normal speed (90 frames a second), while SCAN allows one to sample every 400th frame (i.e., jumps to individual still frames 400 frames apart). Audio is only possible during normal PLAY speed.

The discs feature both moving video and still frame material, offering variety in both the content and pacing of the presentation. For some segments, the discs make interesting use of short, high-speed video sequences, which makes economic use of disc space while allowing more careful viewing of these sequences at slower speeds.

The discs were used with a videodisc system consisting of a player (Sylvania model VP7200), color monitor (Sony model PVM-1910), and remote hand unit (Sylvania model 704427).

Procedure

Children worked in same-sex pairs for two 45-minute sessions, with one exception: One girl worked without a partner for two hour-long sessions. We chose to have the children work in pairs (rather than alone) because the resulting social and verbal interaction provided more access to the children's thinking concerning the use of the system. The sessions were conducted in a small viewing room, and were observed by a researcher who took notes on the children's behavior and comments. The children were asked to "think aloud" as they worked with the disc and to feel free to ask questions of the researcher at any time.

Table 1

Highlights of Disc Options Appearing
on the First National Kidisc and Fun and Games

FEATURE	FUNCTIONS	EXAMPLES
SLOW SPEED	Ability to make videogames easier	Monster Match (FG)
	Ability to study condensed video sequences in detail	Paper Airplane (FNK)
	Ability to observe complex motions closely	Magic Tricks (FNK)
	Ability to experience high-speed travel at more normal speed	Universal Studio Tour (FNK)
STILL/STEP	Freezing on detail of motion video	Athletes in Motion (FNK)
	Mode of response in reaction-time videogames	Target Game (FNK)
	Stepping through still frame games	Flag Game (FNK)
	Getting additional references for activities	Code Maker (FNK)
REVERSE	Manipulating high-speed motions that are interesting backwards	Athletes in Motion (FNK)
	Searching back through game material	Discomobile (FG)
DUAL AUDIO	Variations that increase the amount of play	Double Dutch (FG)
	More tips on how to perform activity	Flying Discs (FG)
	Different kinds of information, e.g., the history of a craft	Pinata Party (FG)
	Answers or translations vs. none	Pig Latin (FNK)
	Instructions, or music alone	Tap Dancing (FG)
CHAPTER SEARCH	Direct access to a minimum of 20 chapters per side	Both discs

The first session was designed to examine how children initially learn to use the various features of the medium through general exploration of the disc. Thus, this session was conducted as a largely unstructured period of exploration with Kidisc. Students were given a remote keypad to control the disc player, and were told that they had the opportunity to see and do a variety of activities and that they should pursue whatever they found interesting on the disc.

Students were initially directed to the brief tutorial segments of the discs. In order to assess the role that such disc-based instructions played in students' learning, the researcher offered no comments on how to use the system. Students were asked to pause after the instructional narrative and describe what they understood about the disc features. Following this, they resumed play through the Kidisc. During the remainder of the session, the researcher observed and documented their use of the various keys and the comments they made.

A second 45-minute session, held about a week later, began with an interview aimed at assessing children's more general understanding of the disc medium. The researcher asked each pair of children to say what they thought one could do with a videodisc, and which aspects of the experience they most liked and disliked. Then the researcher directed the students to several segments on Fun and Games that encouraged use of the SLOW, STILL, REVERSE, and DUAL AUDIO features, and observed their use of these features. In the last 10 minutes or so of the session, students were shown the visual menu of the disc contents on the disc's jacket cover and were told that they could see whatever they wanted. The researcher then noted their use of the menu to explore the contents of the disc.

Results and Discussion

The results are divided into three sections. The first reports on children's initial learning of the disc options and the role of the disc-based instructions and prompts in their learning. In addition, some technical aspects of the hardware which were impediments to learning are discussed. The second section reports on children's use of the visual options in relation to several general goals, such as navigating around the disc and playing with the speed and direction of images. Children's use of audio options is also discussed. The third section reports on individual children's use of the disc options to manipulate the presentation in accordance with their interests and playing styles.

I. Children's Initial Learning of Disc Options

In general, the children were able to learn about the range of disc features within the first 30 minutes of play. By the end of that period, they had a good idea of what most options did and the keys used to manipulate them. For example, they learned that they could use PLAY to see motion video at regular speed, SLOW to see rapid sequences at a more normal pace, REVERSE to back up and repeat segments, and SCAN to move to a different sequence. To a slightly lesser degree, they were able to use STILL/STEP to freeze on a single frame and step through still frames, and DUAL AUDIO to select different audio accompaniments. Furthermore, the children developed an understanding of the similarities and differences among keys on the hand unit; for example, the fact that while several keys may be used to go forward, SCAN takes you farther than FAST FORWARD, which in turn moves you faster than PLAY.

Experimentation played a large role in the children's learning. They did not simply sit through the video as though watching television; all were curious about the remote hand unit and what it might do. One pair experimented with each key even before they saw the disc introduction, pressing one after the other and comparing the results; all the children tried out several keys during the first five minutes of play. Common mistakes, such as hitting the wrong key, were of value in leading children to new options, and in general they did not react negatively when something unexpected happened. Children's learning of the disc features was influenced by the instructions and prompts on the disc and by some features of the remote hand control.

Role of instructions and prompts. In contrast to many other educational discs, the introductory tutorial on Kidisc presents the various technical options in an entertaining, nontext-based way. The chief value of the introductory tutorial seemed to be in providing a sampling of compelling visual sequences that invited experimentation with the features, rather than a straight, factual presentation of the keys and their functions. Using humorous characters, props, and intriguing motion sequences, such as magic tricks involving sleight-of-hand, the introduction most notably encouraged the children actively to experiment with the different technical options. Curious about how the magic tricks were done or what a rapid-fire, still-frame sequence might contain, all but one pair of children voluntarily interrupted the play of linear video in order to try out different features, including FAST FORWARD, SCAN, STILL, SLOW, REVERSE, and PLAY.

The tutorial provided no opportunity for experimentation with separate audio tracks, although this feature was mentioned. Later, it was

seen that this feature was the least clear to children; they tended to use it least and sometimes misinterpreted its function.

Kidisc and Fun and Games contain frequent prompts to tell users that particular options may be useful in an upcoming sequence. There were both visual and audio prompts to indicate FREEZE FRAME, SLOW and STEP FRAMES, and DUAL AUDIO options. The effect of these prompts was to encourage use of the options. Interestingly, the prompts appeared to have different impacts depending on how they were delivered: Children responded more frequently to prompts delivered via the audio track than to written prompts that appeared at the bottom of the screen. The audio prompts were sometimes interpreted as directives that told users what they should do rather than as information about the options available to them. For example, the following exchange between two girls took place after they heard the audio cue, "You can use slow motion or step frames to follow along":

> Ch1: "No, I don't want to slow down; I like it this speed" (laughs).
> Ch2: "Don't they want you to slow down?"
> Ch1: "Yeah, OK..." (she presses SLOW).

Thus, the audio prompts were often followed whether or not the children were really interested in pursuing them.

Other features not prompted on the disc were by no means neglected by the children. FAST FORWARD and REVERSE, SCAN FORWARD and BACK were among the more heavily used options. Student comments suggested that the children learned these easily, in part because they were analogous to features of more familiar media such as audio cassette players and VCRs.

Problems with the remote keypad. Despite the generally effective disc introduction and prompts, some options were more difficult to grasp than others due to the design of the remote control unit and its key inputs. For example, children did not always find it easy to locate the correct button for stopping on a single frame. In addition, once having stopped the image, children were sometimes unable to succeed in stepping through the subsequent still frames, which appeared to be due to the key labels. When they wanted to freeze the video on a single frame, children often pressed the keys marked STOP and PAUSE, which stop the disc from spinning and blank the screen, respectively. The key that freezes the picture is labeled STILL/STEP, a term the children found difficult to associate with stopping the play of video.

The label STILL/STEP reflects the dual function of the key--to freeze the moving video image, and to step forward or back one frame at a time. This dual function posed a second problem for the children, especially since every button on the keypad except STILL/STEP has only one function. Once they had used the STILL/STEP button to stop, children often reached for a different key to step forward, an action that inevitably skipped them much farther than a single frame. Thus, a suggestion for improvement might be to have two different keys, one clearly labeled STOP, the other labeled STEP FORWARD, STEP REVERSE. The keys currently labeled STOP and PAUSE should be renamed, perhaps OFF and BLANK.

Similarly, the keys for manipulating the audio tracks also proved problematic. Children had difficulty selecting the audio track they wanted, and knowing which track was on or off. This appears to be due to several related human and machine factors. Both audio tracks are set at ON when the disc player is turned on. Each track is controlled by a separate key which toggles sound on and off, and the keypad does not indicate the status of each track. Children who wanted to hear one audio track invariably pressed the key for the track they wanted, which often resulted in turning that channel off and leaving the unwanted channel on. Confused about which track they were hearing, children were frequently at a loss to diagnose the problem based on the sound alone.

The disc player, however, had lights indicating the ON/OFF status of the audio channels. Those children who spontaneously noticed the lights and recognized their function used the visual information to manipulate the audio tracks with much greater ease. Two possibilities for improvement of the design might be to have audio toggle keys that rest in different positions for ON and OFF, or to incorporate small lights into the hand device to indicate whether each is on or off.

II. Children's Use of Features in Relation to Different Goals

Having learned about the disc player's technical options, and having a wide assortment of visual and audio materials on which to exercise them, what kinds of things did children do? Four broad categories of video use were noted: (a) getting around on the disc (i.e., going forward or backward from one place to another); (b) seeing things more carefully and slowly; (c) experimenting with the speed and direction of images (to make certain motions look different and more entertaining); and (d) responding in a game situation to different visual cues. We will also discuss the different uses children made of the audio accompaniment.

Getting around. To navigate around the disc, children had several functions available to them, including FAST FORWARD, FAST REVERSE, SCAN, PLAY, and SEARCH. Children quickly developed a facility with the FAST REVERSE and FAST FORWARD functions as ways to back up and see motion sequences again, and get quickly to the end of a segment. Their overall ease in using these may have been due in part to the similarities between the videodisc options and features of more familiar media, such as audio cassette players and VCRs. All the children were familiar with VCRs, and several made spontaneous comparisons while working with the disc. "Fast forward," one boy asked, "that's just like on a tapedeck, right?"

As noted earlier, the children understood the differences between various video options. For example, they understood that SCAN skipped them farther ahead than FAST FORWARD, and FAST FORWARD went faster than PLAY. In addition, getting around the disc contents required an understanding of the appropriateness of the different options for various kinds of material. For example, for activities involving still frame material (where successive frames may have little in common visually) SLOW and STEP are more appropriate modes for moving around than are FAST FORWARD, FAST REVERSE, and SCAN, which tend to be more appropriate to motion video (film sequences with 30 frames per second).

Although children learned what each key did, they had some initial difficulty knowing which functions were appropriate to different kinds of material. For example, in the beginning they sometimes pressed the SCAN button when they wanted to move locally within an activity segment, or they used STEP to move slowly through a large number of motion frames. Through trial and error, however, they gradually refined their strategies and discovered the appropriate functions for different kinds of material.

Over time, children grasped the useful distinction between SCAN and the other functions--that SCAN is most useful for moving between segments and the others for moving within segments. SCAN was understood as the function that "skips ahead very far, very fast" or that can be used "to back up a lot." In general, children were quite willing to exercise their judgment by scanning out of activities that didn't interest them. As one boy put it, "Some of the keys you use when you're bored, to get to something else."

Aided by the visual index of the contents provided on the disc jacket, children also used the CHAPTER SEARCH function to move directly to the beginning of segments they wished to see. (Since the SEARCH function was not part of the disc tutorial, the researcher gave the children a brief explanation of the use of chapter numbers

and the search key.) This was an option they used very adeptly, comparing it to "loading programs" on a computer and choosing channels on television.

Seeing things more carefully. Having discovered the freedom to alter the speed of visual presentations, children made effective use of SLOW and STILL to examine many motion sequences more carefully, which met four different aims:

1. The children enjoyed seeing small fractions of movement that are difficult to observe in real time, such as a person's "frozen" eyeblink or the twist of a dog's body when it leaps for a mid-air catch. As one girl commented, "You can do neat things with [STILL/STEP] like see little in-between movements that you usually don't notice."

2. They often used SLOW and STILL to repeat complex actions bit by bit in order to learn how they were done. For example, children successfully duplicated a magic trick (using materials provided by the researcher) and made sign language letters after watching and stopping video demonstrations of these activities.

3. The children sometimes studied the details of a particular scene or frame in order to answer a game question or simply out of curiosity.

4. They often needed to back up and watch a sequence that in PLAY mode went by too quickly to grasp, such as a series of still frames, a segment of condensed video, or a brief instructions screen. As one boy said, "If the pictures are going too fast, you use SLOW and STEP to see what they are."

There are two qualifications regarding children's enjoyment in viewing things more carefully using SLOW and STEP. First, as noted earlier, the delivery of audio by standard videodisc players is possible only when the machine is operating at PLAY speed. Children found the absence of audio at SLOW speed somewhat disconcerting, and for some this proved to be a discouragement to in-depth pursuit of segments they otherwise found interesting. Second, children didn't take full advantage of STEP FRAMES as a way to see extended physical movements and motion sequences frame by frame. That is, the use of STEP FRAMES was restricted to stepping through unique frames or, in a motion sequence, stepping only one or two frames forward or back. This may have been due, in part, to the fact that the key was not clearly labeled, as noted above.

Playing with speed and direction of images. Children seemed to get a lot of enjoyment out of speeding up different motion sequences

and playing them in reverse. Usually this was an effect they discovered while using FAST FORWARD or REVERSE to move around locally; sometimes it was the result of hitting the wrong key. Children often found the surprising results very amusing. Eventually they realized they could enliven what they otherwise found to be uninteresting segments (e.g., a dancing lesson they thought was "stupid") by toggling the speed and direction of play. In particular, children enjoyed reversing the direction and manipulating the speed of motion sequences featuring the movements of humans (e.g., dancing or athletics) and animals (e.g., a dog's mid-air catch of a frisbee played in reverse caused one girl to laugh and exclaim, "I didn't know dogs could throw frisbees!"), and other nonreversible motions in nature (e.g., a river that could be made to "flow uphill").

Responding in a game. Among the disc segments that children spent the most time with were several game-like video activities requiring quick motor responses to visual cues of very short duration. The most common mode of response called for in these games was to freeze the video at the right moment using the STILL button. A typical example was the Kidisc "Target Game," in which children had to freeze on a "landing pad" of only one frame--the "bull's eye" of an animated target. Interestingly, children viewed the use of the freeze frame option in this kind of game context differently than they viewed other user options. "I like this," said one girl, "because you get to do something yourself, instead of just watching and listening." Thus, although they used the same key to stop and step through other material, using it in an environment with a focused goal led children to perceive this as a more interactive experience.

Children also chose the speed at which to play through the game images, thus controlling the level of difficulty. They soon discovered, for example, that they could use SLOW to make the game easier and PLAY to make it harder. It should be noted that total control over the speed of images allows choices that could make the game trivially easy, thus depriving it of its essential game-like quality. For example, a pair of boys discovered that they could use STILL/STEP to step through frame by frame until they reached the bull's eye. "It's weird 'cause you can sorta cheat. You can sneak up to the bull's eye real slow and get 100 points every time...but then it's not that much fun." These boys deliberately set a challenge for themselves, and came to understand that without such a challenge the game was not truly a game.

In an interesting way, then, children were able to create the game context as well as play in it. Initially, this posed problems for some children, since such user control is not a part of traditional video games, and since they were hampered by the keypad design problems

noted above. However, there was a good deal of collaborative talk among children about how to manipulate the hand unit.

Audio. Sound was an important component of the videodisc experience. The children generally enjoyed the variety of musical and narrative accompaniments presented on the discs, and sometimes made favorable comments concerning particular audio tracks. When interviewed, most pairs of children remarked about the absence of sound at speeds other than PLAY. The occasional loss of audio may have served to increase the children's awareness of sound as part of the normal experience of video.

Children found the absence of audio somewhat disconcerting at times. As one girl said, "The only problem with slow and fast and step frames is that you don't get any sound with them." Some children were reluctant to proceed at other speeds, even when they had chosen to slow down or speed up, because the sequence seemed less interesting without sound. As a result, they missed working with the disc in ways they might otherwise have enjoyed. Over time, however, children found creative ways of preserving some aspect of the audio, for example, by toggling the PLAY and STOP buttons to get a slower, if stilted, motion and a staccato sound track. After working with the disc for some time, the girl quoted above came to feel that "It just means you have to watch things at least twice to hear them talking and to see things better."

Dual audio tracks. As described earlier, the two separate audio tracks provided children with different learning options, such as a greater number of jump-rope rhymes, or different levels or types of instruction for games or arts and crafts activities.

With a choice between two audio tracks for a single visual segment, children could do several things: listen to both tracks at once; randomly switch back and forth between the two channels; read the text messages indicating what the two tracks were and make a choice on this basis; randomly turn off one and listen to the other; listen to one then the other, toggling the tracks on and off in order to ascertain which was most interesting or at the most appropriate level; listen to one audio track all the way through, then reverse, switch tracks, and play through the segment again to hear the different audio.

In spite of this variety of potential interactions, children tended to explore the visual options more than they did the audio options. Audio was important to them as part of the video experience, but the notion that it could be manipulated in relation to the video was clearly unfamiliar to them. Their grasp of this feature was further influ-

enced by ambiguities with the keypad and the differing matches between audio and visuals in the various activities.

As mentioned earlier, both audio tracks are automatically set at ON. As a result, in those segments featuring dual audio tracks, children were confronted with the cacophony of conflicting audio channels. The experience of hearing two different sound tracks simultaneously was new to most children, since it had no ready analogy to other media with which they were familiar. By the end of the first session with the disc, all the children were able to separate the audio tracks so that they were hearing only one.

Children initially responded to the novelty of conflicting audio in three ways: For one pair of girls, it wasn't immediately clear that that there was a choice to make; they listened to both channels for a while and only tried the control keys when the confusion didn't resolve itself. Another pair liked the cacophony of voices and kept listening to both tracks because "it sounds funny, like in class with everybody talking." A few children, however, experimented with the audio keys fairly quickly, much as they did with the other video-related options. Again, it should be noted that children found the lights on the disc player helpful in indicating whether the audio channels were on or off.

Having heard one audio channel, most children were interested in exploring the second track. Their strategy was to play through one track in its entirety, scan back to the beginning of the segment, switch channels, and play through a second time. If they liked the segment, children were usually content to watch it twice through in its entirety, despite a lack of visual novelty. However, if the visual content of the segment was less interesting to them, they sometimes became bored with the second track and scanned to a different activity. A primary reason for exploring the second track was curiosity about what it was like; few children consulted the second track for a purpose such as getting information on a particular topic.

When interviewed, children were able to articulate the differences between the two audio tracks (e.g., "You can have talking or music"; "Audio 1 gives you information, and if you want more tips you press Audio 2"). Often, children were able to discriminate between different levels and types of detail in the information presented. For example, when asked why he would choose one track over another, one boy replied, "I'd pick channel 1 to learn how to hold [the frisbee], and number 2 to see how to make it skip." One girl said of the audio tracks accompanying a pinata-making segment, "One tells you how to make them, the other tells you about where they came from."

As discussed above, hearing the two audio tracks together proved to be confusing for the children. In addition, the idea of having two different sound tracks simultaneously available for the same visual sequence was brand new to them and not always clearly understood. Children developed some interesting notions about the way audio and video components were related; several seemed to think that choosing to hear a different audio track would also alter the visuals. One boy with this expectation voiced some disappointment: "We've seen this before...the sound is different but the pictures are the same...let's see something else."

Even more interesting were the responses of a few children who thought the video was different when viewed with different accompaniments. For example, one video segment showed a group of people playing frisbee and occasionally tossing the frisbee to a dog. One of the accompanying audio tracks focused on the technique of holding and throwing the disc; the other addressed technique but also contained several tips on teaching a dog to play. Two girls described the repeated segment as follows: "The first time it showed you how to throw and catch it; this time it showed you how to teach your dog to play." It would appear that the second audio track made the parts of the video that showed the dog more salient to the children. The same children thought another video segment was different when shown with separate audio tracks. Different sound tracks caused these kids to "see" the same material in two different ways.

III. The Medium's Flexibility and Differences Among Children

Children possess a variety of interests, styles of play, and attitudes towards learning. Did the videodisc medium accommodate these differences? We were interested in seeing whether different children worked with the disc material in qualitatively different ways. However, our small sample did not represent a carefully selected range of individual differences in learning styles; our purpose was to see whether the inevitable differences between children (e.g., idiosyncratic likes and dislikes) showed up in their use of the videodisc. We did not obtain independent measures of the children's likes and dislikes.

We found that the technology allowed the children's diversity to be exercised in at least three ways: First, children worked with the same set of visuals in distinctly different ways. Second, children made up different kinds of games, independent of the intentions of the disc designers. Third, children's comments after the sessions indicated that their experience with the disc was in some ways continuous with their individual experience outside the sessions.

Variations in playing through the same sequence. One dimension in which children clearly varied (usually along gender lines) was a preference for fast-action games versus activities that involved scrutiny of the visual images. Some children (usually boys) enjoyed the challenge of game-like video activities in which rapid responses were necessary to achieve high scores. Others (often the girls) favored guessing and recognition games where they had to examine visuals for clues to a problem, or question-and-answer games where they could verify their answers by reexamining images. In the course of playing through the disc, children tended to favor one or the other kind of activity.

Some sequences, however, which successfully incorporated the flexibility afforded by the disc options, provided an appealing play environment for children with both kinds of interest. For example, the "Discomobile" activity, a simulated drive through a New England town, offered high-speed "surrogate" travel, intriguing scenic detail, and a game component in which players had to act quickly to freeze the video whenever a stop sign appeared. A pair of children who liked video games drove through the town twice each, trying to improve their score by stopping at all the stop signs. In contrast, a pair who liked playing with interesting human motions did not take the video game component seriously, but saw in the segment a wealth of amusing visuals to manipulate. Backing up to a see a stop sign they had missed, for example, they began playing with a fragment of video showing a walking dog and exclaimed, "Oh, look! You can make the dog walk backwards!"

At the end of the "Discomobile" activity, there were trivia questions on particular details of the scenery. In answering the questions, children pursued three different strategies for reviewing the visual sequence. Three girls who liked guessing games went through the sequence once, noticing as many details as possible, and then guessed the answers to the questions without further recourse to the sequence. In contrast, the pair of boys who enjoyed video games sought a strategy aimed at getting the maximum number of points: They read through several questions at a time before scanning back to the sequence and finding as many answers as possible. Finally, a pair of boys and a pair of girls proceeded through the questions one by one, treating the simulated drive as a database of visual clues to each question and checking each answer as they went.

Inventing their own games. In addition to working at games that were part of the disc design, the children were able to improvise on the disc visuals and make up games of their own. For example, one pair of boys spontaneously decided to see if they could recognize the U.S. flag in a long series of still frame flags, using only PLAY

to flip through the stills at high speed. Other children, having noticed details in the visuals, made up questions for their partners to guess at, such as "What country is this?" (in the segment with the flags), or "Where do you think we're flying over?" (in a simulated airplane ride). A pair of girls made a game of searching for scenes with human figures and then toggling the FORWARD and REVERSE keys to "make 'em dance." Thus, the videodisc options were used to yield a variety of games created by the children themselves.

Connections to other activities. Some of the children's behavior and comments during the sessions indicated that they saw connections between the videodisc work and activities they were engaged in outside the sessions. In the flag game, for example, children recognized the flag of Ethiopia, a country they were studying in school, and chose to take paper and pencil and carefully draw the flag to show the rest of their class. They then searched through and found the flags of surrounding countries, and drew them as well. (For further documentation of curriculum links between videodisc and nontechnology-based learning in the classroom, see Char & Tally, 1986.)

Children found aspects of the disc experience sufficiently appealing to wish to share them with other children outside the disc setting. Most were eager to learn some particular content, such as a magic trick, in order to show their friends. Having learned a trick, several children performed it in front of their classmates and teacher.

Children also found more form-oriented aspects of the visual experience highly entertaining. The disc features themselves were the subject of one game that was played in class during "free time." Children improvised silly dance steps to represent each of the different options, which one youngster would call out at random, shouting, for example: "Fast forward!" "Slow!" "Reverse!" "Freeze!" Apparently, children not only had a good grasp of the videodisc features but found them entertaining and fun as well. In sum, these various connections seem to indicate that working with the videodisc was not an isolated experience for children but was stimulating enough to spill over into other daily activities.

Conclusion

In sum, this exploratory study revealed that videodiscs can offer children an experience that is very different from linear television. They easily learned, via experimentation, to make use of many of the novel audio and visual options afforded by videodiscs. Instructions and prompts that functioned to encourage such experimentation were particularly successful. While minor problems such as the configu-

ration of the remote keypad somewhat impeded learning, children managed to take advantage of a a wide range of videodisc options, including SLOW, REVERSE, FAST FORWARD, STEP FRAME, SCAN, and CHAPTER SEARCH.

Results also indicated that with control of the medium children meaningfully applied the disc options to a range of goals, including getting around on the disc, seeing visual sequences more carefully, playing with the speed and direction of images, and responding in a game environment. In addition, audio proved to be a valuable component of the videodisc experience for children. However, they did not immediately grasp the dual audio feature. Their difficulties were both conceptual--because the idea of having two audio channels had no precedent in their experience--and manual--due to the configuration of the keypad. In any case, the relation of the audio to the visual component of the programming was one of the more interesting aspects of the study; children's perceptions and misperceptions in this regard indicated a subtle yet powerful interaction between audio and visual components, which is deserving of further research.

In its flexibility the videodisc medium provided support for children's diverse interests and playing styles. Different children succeeded in working with the same set of visuals in distinctly different ways, and many invented their own games, apart from the intentions of the disc designer. The children's ability to invent games easily seems to indicate that the videodisc medium could serve as a vehicle for children's creativity as well as for the delivery of information and entertainment. Finally, the children's enthusiasm for videodisc extended beyond the research setting and influenced some of their other activities and interests.

The observations of children interacting with this new medium strongly suggest that they are able to handle videodisc programming that leaves open the opportunity for exploration and self-motivated learning.

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